United States Department of Agriculture
Agricultural Research Service

Range and Pasture Research

$$Tr = \frac{(H_2O)_a - (H_2O)_{int}}{r_a + r_s}$$

$$Ps = \frac{(CO_2)_a - (CO_2)_{chl}}{r'_a + r'_s + r'_m}$$

Range and Pasture Research

Framework for the Future

Of the more than 1 billion acres of grazing land in the 48 States and Alaska, approximately 928 million acres are rangeland and pastureland and about 174 million acres are forest land. This vast resource provides grazing for most of the sheep and cattle in the United States and food and habitat for wildlife, including deer, antelope, and elk. It constitutes about half the U.S. land area that provides the Nation's surface and subsurface water resources. In addition, it provides areas for recreation and other esthetic pleasures and is important as sources of oil, coal, and other minerals.

The range and pasture resource has a diverse and complex array of ecosystems—from the desert grasslands of the Southwest to the rolling bunchgrass steppes of the Palouse. Each year the southwestern grasslands have 9 inches of annual precipitation with over 100 inches of evaporation potential, while the bunchgrass steppes have up to 25 inches of annual precipitation with less than 40 inches of evaporation potential.

The range ecosystem is a complex of biological and physical components. These components include plants and animals, soil and soil micro-organisms, atmospheric gases, and climate and solar energy.

Because of their wide expanses, ecological diversity, and often harsh environments, rangelands are far more difficult to manage successfully than cropland. Rangelands return less income, cost more to operate, are less productive, and are more subject to soil erosion than croplands. The objective of range research is to understand how to manage these factors for the highest returns to land owners and managers.

ARS range and pasture research serves the needs of widely divergent interests: cattle and sheep producers; agricultural chemical, seed, and implement businesses; land managers of the U.S. Department of the Interior's Bureau of Land Management, Bureau of Indian Affairs, and Fish and Wildlife Service; and action agencies such as the U.S. Department of Agriculture's Extension Service, Forest Service, and Soil Conservation Service. ARS scientists are also closely associated with universities throughout the United States, often working jointly with university personnel in the same laboratories or in the same range and pasture research stations.

Goal

The goal of ARS scientists engaged in range and pasture research is to make the ecosystem more productive so as to increase returns to the livestock producer but not at the expense of the resource base.

Maintaining harmony with other resource uses—water, wildlife habitat, and recreation—while enhancing forage production is of paramount concern.

This research will concentrate on those major ecosystems where range and pasture are economically important. It will emphasize the dynamics of ecosystems; primary production (including germplasm enhancement); consumption of primary productivity; and nutrient, energy, and moisture cycling. The research will be interdisciplinary, drawing on expertise in different sciences, including soil science, plant physiology, plant genetics, ecology, mathematics, chemistry, animal physiology and animal genetics, sociology, and economics.

Understanding the complex interactions within the ecosystems, such as the long-term effects of grazing, stresses to the environment caused by grazing animals, management risks, and economics, will be enhanced through computer simulation.

By better understanding how grazing system components interact, ARS seeks basic knowledge to overcome obstacles to management of the range and pasture resources. To sustain or enhance management of these resources, ARS will develop a knowledge base about primary production processes and responses to ecologic disturbance. These principles can be projected to specific sites within the various ecosystems. Research will continually strive to identify new knowledge so that ecosystems may become self-sufficient—an essential goal because of the rising costs of labor, fertilizer, annual reseeding, and control of undesirable plants.

Integrated range research will focus on the entire resource management system, including plant, animal, environment, and physical components.

Organization

Because of the diversity of ecosystems, range and pasture are influenced by various levels of capital, labor, and management. Research will be organized to incorporate the ecosystems in the most efficient research system possible by the use of major physiographic regions. Within these regions, the primary ecological divisions can be considered to be the dominant lifeforms—grass (plains and prairies), shrub (shrub-steppes), and trees (savanna and woodland). ARS range and pasture research will focus on the following:

- **Great Basin**—mountain grassland, desert shrub-steppe, sagebrush-steppe, mountain shrub-steppe, woodland.
- **Great Plains**—plains grassland (northern, central, and southern), prairies, Texas savanna.
- **Southwest**—desert grassland (southwestern), annual grassland, southwestern shrub-steppe, woodland.
- **Southeast**—pine and pine-oak savannas and woodlands, prairie (coastal plain).

The biological productivity of these ecosystems is normally limited or regulated by the extent to which the environmental components can be modified. Examples of such modifications are revegetation with more productive plant species, better management of resources, and shifts in kinds and classes of grazing animals.

Structure of the Research Program

The ARS range and pasture program is strategically distributed within most physiographic regions. The mix of disciplines at each research location is put together to meet regional and national research goals. Scientific teams will conduct both basic and applied range research. A stronger emphasis, however, will be placed on problem-solving basic research that is long term and of higher risk.

Within each physiographic region, the research program will be comprised of three components. Research units within each region will be staffed according to one of two research modes.

Program Components

Three basic components comprise the research program:

- Basic processes and functions of ecosystems;
- Integrated renewable resource management systems; and
- Innovative theories.

Ecosystem processes are essentially basic functions and mechanisms and do not vary geographically. The research challenge is to understand the processes operating within the various ecosystems.

Staffing Modes

Research units within each region will be staffed according to one of the following research modes.

1. Basic processes and mechanisms (biotic interactions research)

   Scientific teams, focusing on problems identified as obstacles to managing renewable resources, will plan and conduct research at various locations. They will focus on understanding basic processes and mechanisms of interaction. Research programs will also describe and quantify soil-climate and plant/animal relationships, as well as others. These units will further serve to identify new problems to support integrated locations.

Examples of research programs include:

- Climate-soil-plant processes
- Ecologic site-succession processes
- Hydrologic-erosion processes
- Vegetation establishment processes
- Plant-animal nutritional behavior interactions
- Plant genetics-cytogenetics, biochemistry-bioengineering processes
- Genetics, seedling establishment and seed production of range and pasture plants
- Characteristics of poisonous and noxious plants for control, use, and management
- Exotic and native weeds ecology, management, and chemical and biological control

2. Integrated systems

   Teams of scientists will work on range and pasture systems at strategic locations within broad geographic areas. They will have access to representative historic data bases with suitable computing capacity or a critical or intellectual mass of scientists capable of interacting with the research teams, or both. Models such as SPUR (*S*imulation of *P*roduction and *U*tilization of *R*angelands) will provide technology and formats for integrating and applying knowledge for pasture and rangeland. Other activities will include testing actual on-the-ground management systems.

Examples of research programs include:

- Range/pasture systems integration
- Basic ecosystem function research
- Ecosystem modeling
- Socioeconomic values of range ecosystem resources
- Management simulation modeling
- Remote sensing research

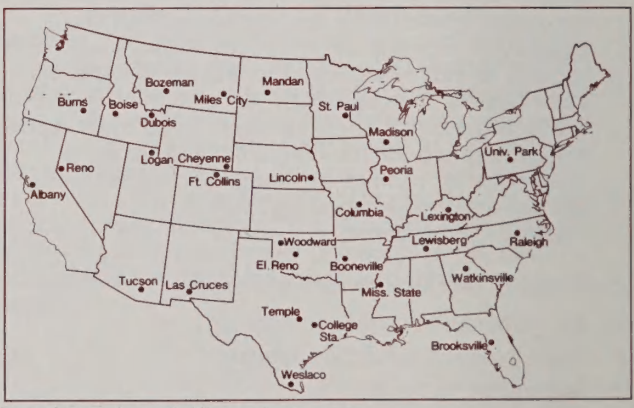
"Bonded" sheep and beef cattle on the Jornada Experimental Range. Cloth tape encircling the animals' bodies show their bonding groups for long-distance identification.

New Theory Development

All ARS range and pasture research locations will develop and test ecosystem and renewable resource-management theories. Research leaders and teams will be assembled, when appropriate, and electronic communication networks will be used extensively.

Examples of major theoretical areas may include:

- Disturbance theory
- Resource decision theory
- Management of stressed ecosystems
- Landscape ecology



Locations where ARS conducts range and pasture research.

Range and Pasture Research Locations

Arizona, Tucson—Southwest
Aridland Watershed Management Research Unit—Rangeland hydrology and erosion research, plant ecology, and weed control

Arkansas, Booneville—Southeast
South Central Family Farm Research Center—Small acreage integrated pasture-management systems

California, Albany—Great Basin and Great Plains
Biological Control of Weeds Laboratory—Biological control of introduced rangeland weeds

Colorado, Fort Collins—Great Plains
Great Plains Systems Research Unit—Simulation modeling, range ecology, grazing systems, and arid land legume genetics

Florida, Brooksville—Southeast
Subtropical forage systems research

Georgia, Watkinsville— Southeast
Southern Piedmont Conservation Research Center—Integrated pasture management systems

Idaho, Boise—Great Basin
Sheep Experiment Station—Grazing systems, ecology

Illinois, Peoria—Temperate East
Northern Regional Research Center—Chemicals in tall fescue affecting forage utilization

Minnesota, St. Paul—Eastern Humid Region
Forage crop management systems

Mississippi, Mississippi State—Southeast
Forage and livestock management systems

Missouri, Columbia—Southeast
Forage/Livestock interface

Montana, Bozeman—Great Plains and Great Basin
Rangeland Insect Laboratory—Biology and control of grasshoppers in the Great Plains and Great Basin

Montana, Miles City—Great Plains
Ft. Keogh Livestock and Range Research Station—Increasing forage efficiency on rangeland

Nebraska, Lincoln—Great Plains
Forage and Range Research Unit—Breeding, genetics, improved forage quality, and forage entomology of perennial grasses for Central Great Plains

Nevada, Reno—Great Basin
Renewable Resource Center—Range ecology, management, and improvement

New Mexico, Las Cruces—Southwest
Jornada Experimental Range—Improving forage and livestock production in arid rangelands

North Carolina, Raleigh—Southeast
Forage growth and nutrient characterization of pasture

North Dakota, Mandan—Great Plains
Northern Great Plains Research Laboratory—Biology and management of rangeland resources of the Northern Great Plains

Oklahoma, El Reno—Great Plains
Grazing management, forage physiology, ecophysiology, complementary forage systems

Oklahoma, Woodward—Great Plains
Southern Plains Range Research Station—Range ecosystem management: rangeland systems and management of plant/animal interactions

Oregon, Burns—Great Basin
Squaw Butte Experimental Range—Dynamics of forage growth and defoliation on western intermountain sagebrush steppe ecosystem

Pennsylvania, University Park—Eastern Humid Region
U.S. Regional Pasture Research Laboratory—Forage germplasm improvement and forage management systems

Tennessee, Lewisburg—Southeast
Dairy Experiment Station—Evaluation of fescue and orchardgrass as companion crops with alfalfa

Texas, College Station—Great Plains
Weed control on pastures and rangeland, genetics of warm-season grasses

Texas, Temple—Great Plains
Grassland, Soil, and Water Research Laboratory—Genetic improvement of warm-season forage grasses for pasture and rangeland, ecology, biology, biocontrol, and management of weeds and brush on rangeland

Texas, Weslaco—Great Plains
Rangeland ecology and remote sensing

Utah, Logan—Great Basin
Forage and Range Research Unit—Physiology of carbon-nitrogen metabolism and of stress responses of range plants in the semiarid west, germplasm enhancement and breeding of forages adapted to intermountain rangelands

Poisonous Plant Laboratory—Diagnostic and pathophysiologic aspects of plant poisoning in livestock, plant/animal interrelationships in livestock poisoned by plants, effects on reproduction and offspring

Wisconsin, Madison—Eastern Humid Temperate Region
U.S. Dairy Forage Research Center and satellite locations—Improvement of forage systems for dairy production

Wyoming, Cheyenne—Great Plains
High Plains Grassland Research Center—Effect of ecosystem disturbances on soil and vegetations management, management systems for efficient livestock production from forages, woody species establishment

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